PATENT SPECIFICATION (11) 1 576 616

1 576 616

(21) Application No. 15886/76 (22) Filed 20 Apr. 1976

(23) Complete Specification Filed 25 Feb. 1977

(44) Complete Specification Published 8 Oct. 1980

(51) INT. CL.[3] G01S 3/14

(52) Index at Acceptance H4D 501 507 50X

(72) Inventor: NYALL DAVIES

(19)

(54) IMPROVEMENTS IN OR RELATING TO DIRECTION FINDING SYSTEMS

(71) We, THE MARCONI COMPANY LIMITED, a British Company, of Marconi House, New Street, Chelmsford, Essex CM1 1PL do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:

This invention relates to direction finding systems and in particular to automatic direction finding systems.

As at present known, direction finding systems commonly employ two rotatable loop aerials together with a fixed omni-directional aerial which provides a reference signal. One problem with such systems as at present known is that the usefulness of the bearing information presented for utilisation is often impaired by the effects of temperature and, particularly if the system is a mobile one, vibration.

The present inventor believes that this problem stems at least partly from the fact that it is common practice individually to amplify signals derived from the different aerials prior to utilisation.

The present invention seeks to provide improved direction finding systems in which this problem is reduced.

According to this invention a direction finding system comprises a direction-finding system comprising means for deriving a first signal defining a reference phase; means for receiving radiation from an object whose direction is to be found and producing therefrom a second signal, the phase of which relative to the first signal is dependent on the direction of the object; common amplifying means arranged to amplify first one and then the other signal; means for storing information defining the phase of one of the amplified signals; and means for obtaining an indication of the phase of the other amplified signal relative to the phase defined by the stored information, to find the direction of the object.

In a preferred embodiment of the present invention said first and second signals are combined by a time division multiplexing arrangement prior to amplification in said common amplifying means and amplified signals from said common amplifying means are applied to a corresponding demultiplexing arrangement prior to utilisation. Preferably there are two directional aerials, an omni-directional aerial, means for relatively phase shifting by 90° signals received by the two directional aerials, means for summing said relatively phase shifted signals and means for time division multiplexing said summed signals and signals received by said omni-directional aerial prior to amplification by said common amplifier means.

Preferably again the arrangement is such that following demultiplexing in said demultiplexing arrangement, said signals from said omni-directional aerial are applied to a phase store to provide a reference phase signal for a phase sensitive detector to which is applied said summed signals recovered by said demultiplexing arrangement. The output of said phase sensitive detector will constitute bearing information for utilisation. Normally means are provided for storing the output of said phase sensitive detector.

Preferably said phase store comprises a free frunning oscillator which is arranged to be phase locked by said signals from said omni-directional aerial and recovered by said demultiplexing arrangement.

Preferably said phase sensitive detector comprises two squaring amplifiers, one for said reference phase signal from said phase store and the other for said summed signals, and a bistable circuit arranged to be set into one of its two states by the leading edge of signals from one of said squaring amplifiers and to be re-set by the leading edge of signals from the other of said squaring amplifiers.

The invention is further described with

reference to the drawings accompanying the provisional specification in which,

Figure 1 is a block schematic diagram of one direction finding system in accordance with the present invention,

Figure 2 is a block schematic diagram showing phase detector 16 of Figure 1 in greater detail

and Figure 3 is an explanatory diagram relating to Figure 2.

Referring to Figure 1, two radio signal receiving directional loop aerials are represented at 1 and 2 respectively, whilst an omni-directional receiving aerial is represented at 3. Signals received by the loop aerials 1 and 2 are applied via respective balanced-to-unbalanced transformers 4 and 5 and respective phase shifters 6 and 7 to a summing circuit 8. Phase shifter 6 is such as to cause a phase shift of 45° in one direction, whilst phase shifter 7 is such as to provide a 45° phase shift in the other direction so as to provide the effect of a single 90° phase shifter in one of the paths to summing circuit 8.

The output of summing circuit 8, together with signals from the omni-directional aerial 3, is applied to a time division multiplexing arrangement 9 controlled by a multiplex generator 10. Signals from the summing circuit 8 and the omni-direction aerial 3, multiplexed by arrangement 9, are applied via a common amplifier 11 to a corresponding time division demultiplexing arrangement 12, also controlled by multiplex generator 10. The demultiplexing arrangement 12 separates out the signals from summing circuit 8 and omni-directional aerial 3, multiplexed by arrangement 9, so that signals from summing circuit 8 appear on output path 13, whilst signals from the omni-directional aerial 3 appear on output path 14. Output path 14 is connected to a phase store 15, which stores the phase of the signals received by omni-directional aerial 3 to provide a phase reference. The output of phase store 15 is applied to the phase reference input of a 0° to 360° phase sensitive detector 16, a signal input for which is provided by the path 13 upon which appear signals from the summing circuit 8. At the output 17 of phase sensitive detector 16 appear bearing information signals which are stored in a store 18 for utilisation in manner known *per se*. Phase sensitive detector 16 will be described in greater detail with reference to Figures 2 and 3.

The phase store 15 may take any of a number of forms known *per se*, but in this particular example the phase store 15 takes the form of a free running oscillator phased locked to the reference signal provided by the signals from omni-directional aerial 3 appearing on path 14.

It will be seen that in the system schematically illustrated in Figure 1 a common amplifier 11 is utilised for all of the signals. This common amplifier need only have good short term stability of gain and phase shift as opposed to the long term stability required if separate amplifiers were used for the different components of bearing information.

Referring to Figure 2, the phase sensitive detector 16 of Figure 1 consists of two squaring amplifiers 19 and 20, one of which, 19, is connected to receive via lead 21 phase reference signals from the phase store 15 of Figure 1, whilst the other 20 of the squaring amplifiers is connected to receive summed signals, originating from summing circuit 8, via lead 13. The output of squaring amplifier 19 is connected to one input 22 of a bistable circuit 23 so that the leading edges of signals from squaring amplifier 19 switch the bistable circuit 23 into one of its two states. The output of squaring amplifier 20 is connected to the second input 24 of bistable circuit 23 so that the leading edges of signals from the squaring amplifier 20 re-set the bistable circuit 23.

The operation of the phase detector illustrated in Figure 2 is demonstrated by the waveforms of Figure 3.

Referring to Figure 3, waveform A represents the squared off phase reference signal appearing on lead 22. Waveform B represents a squared off signal appearing on lead 24 and lagging by 90°, whilst waveform C represents the signal appearing at the output 25 of the bistable circuit 23, in consequence.

Waveform D represents a signal appearing on lead 24 and lagging by 180°, whilst waveform E represents the signal appearing at the output 25 of bistable circuit 23, in consequence.

Waveform F represents a signal appearing on lead 24 and lagging by 270°, whilst waveform G represents the signal appearing at the output 25 of bistable circuit 23, in consequence.

Thus it will be seen that the phase sensitive detector shown in Figure 2 is capable of detecting phase from zero to 360°, as is required in the present case in order to avoid ambiguities.

WHAT WE CLAIM IS:-

1. A direction-finding system comprising means for deriving a first signal defining a reference phase; means for receiving radiation from an object whose direction is to be found and producing therefrom a second signal, the phase of which relative to the first signal is dependent on the direction of the object; common amplifying means arranged to amplify first one and then the other signal; means for storing information defining the phase of one of the amplified signals; and means for obtaining an indication of the phase of the other amplified signal relative to the phase defined by the stored information, to find the direction of the object.

2. A system according to claim 1 in which

the means for deriving the first signal includes an omnidirectional aerial.

3. A system according to claim 1 or 2, including two directional aerials, means for introducing a ninety degree phase difference between signals received from the directional aerials and means for adding the signals after introduction of the phase shift thereby obtaining the said second signal.

4. A system according to any preceding claim and wherein means are provided for storing the indication of the phase of the said other amplified signal relative to the phase defined by the stored information.

5. A system as claimed in any preceding claim and wherein said means for storing information comprises a free running oscillator which is arranged to be phase locked according to the phase defined by the first signal.

6. A system as claimed in any preceding claims and wherein said means for obtaining an indication of the phase comprises two squaring amplifiers, one arranged to receive an output from the said means, one for said reference phase signal for storing information and the other arranged to receive the amplified second signal, the system further including a bistable circuit arranged to be set into one of its two states by the leading edge of signals from one of said squaring amplifiers and to be re-set by the leading edge of signals from the other of said squaring amplifiers.

7. A system according to any preceding claims including two switching arrangements respectively at the input and output of the amplifying means, and means for operating the switching arrangements so that, at some times one of the first and second signals is fed to the means for obtaining an indication of the phase *via* the amplifier; and at other times the other of the first and second signals is fed to the means for storing information.

8. A direction finding system substantially as herein described with reference to the drawings accompanying the provisional specification.

Agent for the Applicants
D. G. ROUSE
Chartered Patent Agent.
Marconi House,
New Street,
Chelmsford,
Essex.

Printed for Her Majesty's Stationery Office,
by Croydon Printing Company Limited, Croydon, Surrey, 1980.
Published by The Patent Office, 25 Southampton Buildings,
London, WC2A 1AY, from which copies may be obtained.

1576616 PROVISIONAL SPECIFICATION
2 SHEETS This drawing is a reproduction of the Original on a reduced scale
Sheet 1

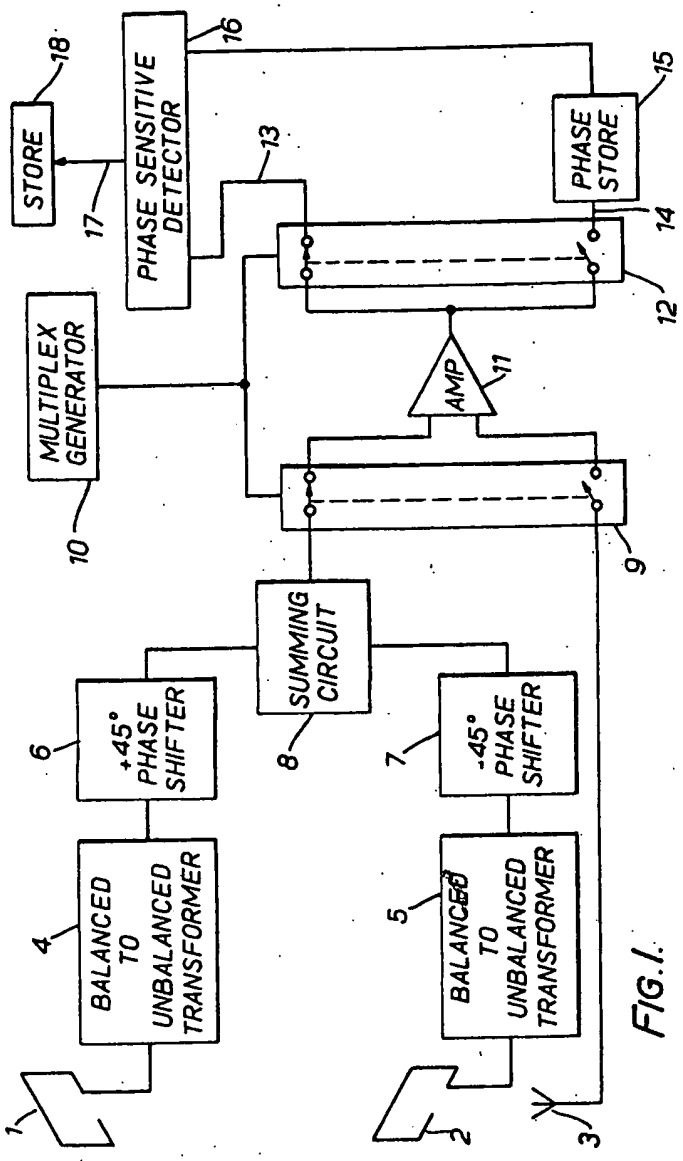

FIG. 1.

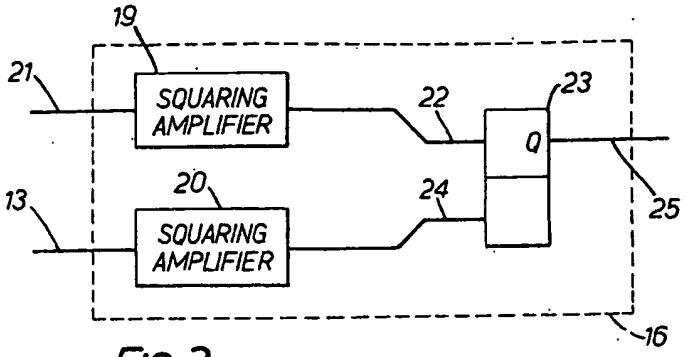
19
21
SQUARING AMPLIFIER
22
23
Q
20
13
SQUARING AMPLIFIER
24
25
16

FIG.2.

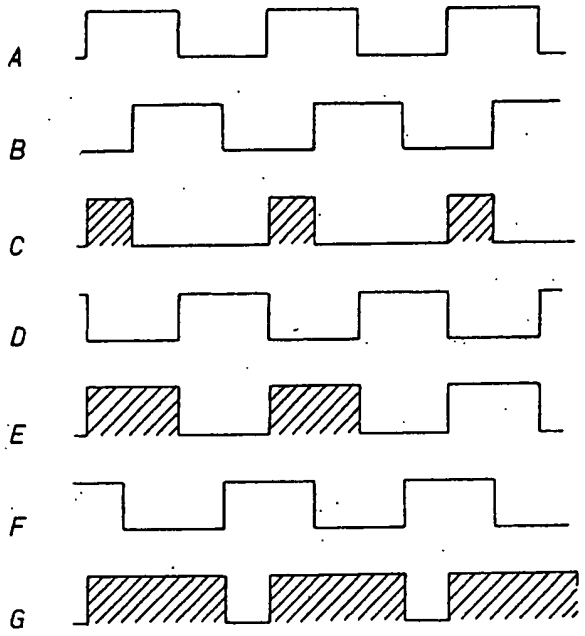
A
B
C
D
E
F
G

FIG.3.